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ELECTRONIC READING: EMERGENCE IN ONLINE TEXT

Alice S. Horning
Email: horning@oakland.edu

Abstract

Gunther Kress, a highly respected literacy theorist, has recently argued that literacy in the "new media age" is significantly different from conventional print literacy (2003). However, much of what happens when readers process text and/or images entails basic processes used in print and electronic environments with text and image. To demonstrate the consistency of the underlying capabilities, we can examine Steven Johnson's (2001) claims about the nature of emergence, which explain key features of how the Internet operates. As we spend more time looking at screens, reading text and processing images, sounds and movements, our print-based reading skills will continue to be challenged. Johnson's analysis can be applied to reading to show that it resembles other emergent systems, showing the same fundamental features: neighbor interaction, pattern recognition, feedback, and indirect control. Similarly, the principles of visual processing and cognitive processing identified by cognitive scientist Steven Pinker (1997), including identification, categorization and discrimination, make paper and electronic critical literacy possible for human beings. Examining the critical literacy demonstrated by readers of both print and electronic text from the perspective of emergence and cognitive science shows the fundamental similarities between them and suggests that the "new media age" isn't really new.

In Emergence (2001), cultural critic Steven Johnson argues that much of the human behavior found on the Internet, including websites, chat rooms, email, online discussion boards and so on, reflects similar behavior in other environments, whether human (as in the construction of a neighborhood) or animal (as in an ant colony). In a similar way, studies of human linguistic processing reflect research on the patterns and strategies of human cognitive processing. Humans are pattern-loving creatures; our willingness to follow both conscious and unconscious patterns is fundamental to human psychology and, when unhealthy, accounts for how psychotherapists stay in business. Following this pattern-loving model to understand electronic reading, then, leads to a clear connection between human cognitive processing mechanisms and reading in print and on the Internet. Gunther Kress, British education and literacy scholar, proposes that we are in a new relationship with text now because of the Internet, such that images dominate over text and the screen dominates over books (2003, p. 1). Kress believes that the screen is a "visual entity" such that text that appears there is treated like an image, following principles of visual design like other images. Images also appear with text, with the result that text, according to Kress, plays a secondary role to image in terms of conveying meaning (Kress, 2003, pp. 65-66). However, the new relationship described by Kress shows many of the characteristics of emergence described by Johnson and explicated by cognitive scientist Steven Pinker's understanding of the mental and linguistic processes (1997). Our new strategies in

electronic environments are consistent with well-established, cognitively-based strategies for reading print, sharing features with other emergent and psycholinguistic processing.

The Nature of Emergent Systems

Johnson (2001) describes emergence as a phenomenon in his book, using examples from ants, cities and software. Looking at the patterns in these examples as well as others from diverse areas, he notes that all of them share a bottom-up development pattern that does not rely on conventional, hierarchical leadership. Instead,

> they are complex adaptive systems that display emergent behavior. In these systems, agents residing on one scale start producing behavior that lies one scale above them… . The movement from low-level rules to higher-level sophistication is what we call emergence. (Johnson, 2001, p. 18)

In a very general way, Johnson's description could easily be applied to reading behavior. At the outset, reading calls for the use of low-level rules to figure out letter-sound correspondences and to build a "sight vocabulary" of familiar words. Over time, though, proficient readers move to a much higher level of sophistication in their ability to process texts, including graphics and images on computer screens.

There is more to the nature of emergence than this relationship of lower and higher level rules. A key feature of systems that show emergent behavior patterns is their developmental growth. Johnson points out that the "forms of emergent behavior that we'll examine in this book show the distinctive quality of growing smarter over time, and of responding to the specific and changing needs of their environment" (2001, p. 20). Here again, Johnson could easily be describing reading. The reading system, you might say, of a good reader, does clearly get smarter over time. At the outset, as Frank Smith notes in his description of reading development, novice readers have a kind of "tunnel vision" (1994, p. 73), since they must attend to the actual display of print on the page, identifying first letters, then words, then meanings. As readers develop skill (i.e., their reading systems get smarter), they need less information from the page and have less tunnel vision. Really skilled readers show this kind of development among others, so that they can also respond to different types of reading materials or different reading situations with different strategies and approaches. Thus, for instance, fluent readers can change their strategies for reading newspapers or trash novels or professional material or websites.

Johnson sets out four key principles of emergence in the central section of his book: "neighbor interaction, pattern recognition, feedback, and indirect control" (2001, p. 22). Each of these principles can be more fully explicated, and the more they are explained, the more they sound like a description of various aspects of reading behavior. With respect to neighbor interaction, for example, Johnson says that groups of ants or people engaged in a community follow a few key rules. First, they need a critical mass of members in order to exchange information effectively. Second, they are composed of relatively simple elements. Third, they need some random experiences with others to comprehend the larger picture of the system of which they are part. Fourth, they notice patterns as they find them in order to grasp the system as a whole. And finally, they notice their interactions and learn from them.

Effective, critical readers engage in something like Johnson's neighbor interaction, following these principles. First, they need a critical mass for information exchange. Sophisticated readers do exchange ideas with other readers and sometimes also with the writer, depending on the situation. The reading may be for a school assignment, for example, in which case it will be discussed with a critical mass of class members. Or it may be pleasure reading

where the reader will meet others, perhaps in a book group, for discussion. Or the reader may hear an interview with the writer on the radio or see or read one on television or on a website. Texts offer plenty of opportunities for interaction, between reader and writer or between one reader and others.

Second, readers use the relatively simple set of elements (letters and/or words) for this exchange of information both with the writer and among themselves (members of a school class, reading group and so on). Not all book reading entails social contact, but it does always involve interaction of readers and writers with a text made up of words. Even if there are images involved, as Kress suggests is the case with "new" media, the same underlying principles are in operation. The Internet may facilitate neighbor interaction, but there are plenty of other modalities that have always been and are still available.

To get the larger picture of the gist of the text, effective readers make use of varied experiences, both their own with the issues under discussion in the text and if in some kind of group, the experiences of others, a third feature of neighbor interaction. Reading scholars agree generally on the importance of prior knowledge and context to successful reading. The patterns in text, resulting from the author's style, the genre of the text and other features, create familiar forms readers use to understand the whole of a text and to learn from the text. These approaches and strategies apply to both print-based and web-based reading.

Interaction appears important to both book reading and screen reading, making them more alike than they might at first appear. The interaction in screen reading is reflected in the pervasive use of email and Instant Messaging, chat rooms, web logs (also called blogs, a kind of public diary posted to an Internet website) and all sorts of other screen-based texts that rely on exchanges between people. At Amazon.com, it is possible to post and read reviews of books, yet another kind of neighbor interaction. Perhaps the modality is different when the interaction is electronic, but the use of interaction in emergent reading of books and screens is quite similar.

In pattern recognition, Johnson talks about the nature of learning, because emergent systems do learn. The learning that goes on is not always conscious in nature (Johnson, 2001, p. 103). One example of this is the way that the human immune system learns to recognize invading germs and stop them. There is feedback that helps make learning possible. And an emergent system will look at a situation and see if it has prior experience of a similar kind (i.e. a pattern match) so it can use what it did the last time.

Pattern recognition is widely used in both book and screen reading in all sorts of obvious and not-so-obvious ways. First, letter and word and even meaning recognition all rely at least to some extent on pattern recognition, as Frank Smith has pointed out (1994, p. 106-108). In addition, though, pattern recognition occurs when readers notice a specific genre of text, like a fairy tale's "once upon a time" or a research report's "Statement of Problem, Review of the Literature, Methods, Results, Discussion." Websites, too, have a kind of genre: Amazon.com and related shopping sites all have similar features as do news sites. Compare www.amazon.com to www.jcpenney.com, and www.msnbc.com to www.cnn.com. As Johnson suggests, pattern matching is helpful because it allows the use of prior experience. In book reading and screen reading, prior knowledge of patterns of many kinds helps the reader create appropriate expectations for the text, enhancing comprehension. Thus, here again the characteristics of reading as an emergent system fit both kinds of reading, showing that they are alike in this area as well.

The nature of the feedback in an emergent system is, as noted above, part of how the system learns and grows. Feedback is the by-product of brain structure, according to Johnson.

Because neurons in the brain fire along densely connected paths, the more often the same set of neurons is activated, the more likely it is that a feedback loop will be created (Johnson, 2001, p. 133-34). This phenomenon is a key characteristic of emergence: "a system of local agents driving macrobehavior without any central authority calling the shots" (p. 137). Such systems, though, are adaptive, responding to both positive and negative feedback to learn and change.

Feedback works importantly in reading as an emergent system. As readers move through any kind of text, print or electronic, they are adding information and the reading system is learning. Each segment of a text or compilation of images on a web page creates a feedback loop that connects that part to the whole. In textbooks, for instance, sections are usually clearly marked with headings. The headings are related to the overall plan of the chapter. The reader makes use of the headings to keep the information structured and related. In a similar way, color for sections of a web page or type font can relate parts of the information displayed. Boxes, drop-down menus and so on are all part of this feedback loop process. Readers' strategies entail using the feedback from each section to get meaning overall. Both books and web pages provide feedback in these various forms, demonstrating that the reading of printed and electronic texts show characteristic emergent behavior.

Finally, emergent systems change the shape of control, since they function without having any essential management. Johnson's example is interactive software for the computer, where the programmer may initially have control in the course of creating the software, but once it is in use, the users take over (2001, p. 174). Emergent systems are still rule-governed, as Johnson explains:

> …their capacity for learning and growth and experimentation derives from their adherence to low-level rules…. If any of these systems—or, to put it more precisely, the agents that make up these systems—suddenly started following their own rules, or doing away with rules altogether, the system would stop working… . Emergent behaviors, like games, are all about living within the boundaries defined by rules, but also using that space to create something greater than the sum of its parts. (2001, p. 181)

Thus, there are some underlying, shared rules governing emergence, but these rules seem to provide a framework or starting point, rather than constraints on development.

In reading, of course, it is the writer who provides the initial framework, or the creator of the web page. But, like other emergent systems, although reading relies on basic linguistic and electronic principles for setting up the system, those principles are simply a starting point. Working within the boundaries of the system, the reader of a book or the viewer of a web page can go well beyond the system to extract meaning. Book readers and electronic readers take control, not only in terms of the creation of meaning, but also in terms of how they will use and share their personal understandings. Book readers may interpret a text or use it in an argument to support their own views as I am currently doing with Johnson and Kress in this paper. Screen readers can manipulate texts in various ways, as Kress points out (2003, p. 166), when forwarding a message or responding to email. They can alter the shape and outcome of a game in a similar way. Here again, in terms of control, book readers and screen readers can exercise a significant amount of control over a text.

Reading is, then, clearly quite similar to other kinds of emergent systems as described by Johnson (2001). It is not so revolutionary as Kress suggests, even if the presence and importance of images marks the shift he describes. The underlying processing of both text and images, whether on the printed page or on the screen, relies on similar and well-established processes. To account for this resemblance, it will be useful to look at the underlying cognitive processes

and perceptual abilities that make reading possible. The mind can do reading, whether in the print of a book or in images on a screen, as an emergent system because the principles that make text processing possible, to be discussed next, work in the same way as the rules that govern emergence. They provide a framework so that humans can "do reading," whether on paper or on screen, but do not constrain what happens to the reader. I hope to show that these guiding principles work for both paper and electronic reading of both text and images.

Processing Mechanisms and Perceptual Tools

In How the mind works, Steven Pinker (1997) discusses human mental functions of various kinds. Certain parts of his discussion bear particularly on abilities important to language and reading of text and images. Pinker's work supports the claim that there must be features of our mental functions, our processing abilities, that relate specifically to language and that help account for how it is that humans are capable of critical literacy. Pinker's description of how the mind works supports the view that a few key perceptual mechanisms help account for how the mind works, particularly when it is engaged in reading.

Pinker claims that the mind works in an essentially computational way that is the result of processes of natural selection over time (1997, p. 21). Several points that arise from this broad claim are the main areas of exploration in his book:

> The mind is what the brain does; specifically, the brain processes information and thinking is a kind of computation. The mind is organized into modules or mental organs, each with a specialized design that makes it an expert in one arena of interaction with the world. The modules' basic logic is specified by our genetic program. (Pinker, 1997, p. 21)

The second of these points sets up an exploration of visual processing and the making of meaning that reveals the fundamental processing mechanisms for literacy. The principles of the visual system are part of the framework that makes reading possible, but as in other emergent systems, they provide only the base for how users make the system work, whether in print or on the web.

In How the mind works, Pinker examines a number of different mental capacities including visual perception. Although reading is only "incidentally visual" (Kolers, 1967), it relies at least in part on the visual array on the page; writing entails the creation of a visual array to be read. So it seems appropriate to start with visual matters. Vision happens when light images enter the eyes and are passed along to the brain for processing (Pinker, 1997, p. 215). Perception is the process of making sense of visual stimuli, including the ability to sort illusion from reality and to insure that we perceive what we see (Pinker, 1997, p. 215-241). Perception requires that we make some assumptions about the world, that our eyes work together to provide what he calls "stereo vision" (the image from each eye is fused into a single picture), and that we can capitalize on this input to make sense of the world. Pinker suggests that stereo vision is a model of how the mind works:

> Stereo vision is … a connection between mental computation and awareness that is … lawful… . It is a module in several senses: it works without the rest of the mind (not needing recognizable objects), the rest of the mind works without it (getting by, if it has to, with other depth analyzers), it imposes particular demands on the wiring of the brain, and it depends on principles specific to its problem… . Though stereo vision develops in childhood and is sensitive to experience, it is not insightfully described as "learned" or as "a mixture of nature and nurture"; the development is part of an assembly schedule and

> the sensitivity to experience is a circumscribed intake of information by a structured system. (Pinker, 1997, p. 241)

Pinker's analysis supports several of my claims. First, there are underlying principles operating that make literacy possible, hence the claim of the lawfulness of stereo vision. The visual capacity of humans is a distinct mental system, hence its modularity, but is connected to other mental systems. Typically, literacy development occurs in childhood, and, as Pinker says, is sensitive to experience, usually though not always a by-product of specific teaching. Kress points out, for example, that his son plays elaborate video games that entail extensive reading at speeds much beyond his own capabilities and with a depth of comprehension and decision-making that is not obviously taught in conventional school work (2003, p. 173). Increasingly, literacy development occurs not only through interaction with the printed page, but also through interaction with the screen, whether video or Web. In a fundamental way, Pinker is describing the emergent character of reading.

Vision works under some key constraints that pertain to literacy. First, "vision is not a theater in the round" (Pinker, 1997, p. 257). That is, the eyes focus on what is in front of them and everything else, though generally perceived through peripheral vision, is unfocused and much less clear. In reading, this feature of vision means that readers see only the patch of text in focus at any given moment. A series of focus points or fixations on a line of text provide the perception of reading continuous text, but that is not how text processing actually happens.

Second, humans do not have x-ray vision. It is not possible to see what is inside a box. Vision works strictly on the surface of the world, a sort of "what you see is what you get" in the sense that what you see is all you see, and all you see is two dimensions, not three (Pinker, 1997, p. 257-258). You may intuit or guess what is in a box, but you don't actually see it or perceive it. Perception can be fooled into seeing what isn't actually there, as in the well-known image of a vase that can also be two faces in profile which can be seen at http://inner_magician.tripod.com/bio.htm (Pinker, 1997, p. 259). Perception also relies heavily on redundancy to make assumptions about what might be there, even though we don't see it.

This limitation of vision and its reliance on redundancy account for a big part of how reading works. We don't actually look at or see or need to see much of what is on the page, hence Kolers' claim that reading is only "incidentally visual" (1967). These characteristics explain how it is possible to read more than 200 words per minute with good comprehension. The more predictable (i.e. redundant) a text is, the less a reader needs to see to get meaning. Good readers can breeze through Danielle Steele or Tom Clancy at 600 words a minute or more. Kids playing video games are using the same fundamental processes and the result is moving through text and images at the same blinding speed, as Kress points out (2003, p. 173).

Because vision has perspective and a sense of the boundaries between objects, we can see and perceive (i.e. make sense of our sights) only one thing at a time. In the faces/vase image or the rabbit/duck image available at http://members.lycos.nl/amazingart/images/rabbit_duck_3.jpg or the Kanisza triangle image available at http://www.iknow.net/CDROMs/eyephys_cdrom/geometry.html, if you see one possibility, the other is gone. The brain simply cannot process two images at once; the visual system does not allow it (Pinker, 1997, p. 259, 293). As Frank Smith explains, literacy processes capitalize on this feature of the visual system. Smith contends that literate humans actually look at or see only a sampling of letters or words in reading, but perceive through them the meaning of a text (Smith, 1994, p. 151-165). On the Internet, the use of images relies on our processing just what is displayed.

Pinker describes some other features of how vision works that are not crucial to reading, such as the fact that most of vision is two-dimensional, with depth functioning as .5 of a third dimension because it is somewhat less important in overall perception and because it requires so much space in the overall system. Pinker's analogy is to computer systems; he points out that graphics take much more computer storage than text, consuming more memory and taking longer to load to the screen (1997, p. 260-261). The visual system tries to limit demand by taking in depth in a limited way, to reduce the load of information; shifts in the frame of reference as we look around the visual world make the discounting of depth possible without a loss of information.

These perceptual features are the major tools that make it possible for human beings to work with written language. The visual system as described by Pinker and others provides the basic equipment that makes literacy, whether in a book or on a screen, possible as an emergent system. To work at literacy, humans need and have tools with which they can understand and produce written text. These tools consist of three main kinds of perceptual capacities, all of which are essential to both book and screen literacy: identification, categorization, and discrimination.

Identification/Recognition

The first of these capacities is the human ability to recognize and/or identify letters, words and other written forms, such as punctuation. As I have noted previously in The Reading Matrix (2002), recognition, in psycholinguistic terms, includes both remembering, i.e. "conscious recollection of seeing the item previously" (Knowlton, 1998, p. 254), and knowing, i.e. "recognition in the absence of such recollections" (Knowlton, 1998, p. 254). These general abilities apply not only to letters and words but also to meanings in written language processing. Identification makes it possible for us to look at A and a and *A* and label all of them as letter 'A'. Identification refers specifically to the ability to name the letters, words or other written forms.

It may not seem that identification or recognition is important to literacy. One of the great debates in the teaching of reading and writing concerns whether it is necessary for readers and writers to identify, that is, to label, letters and words at all; this issue plays out in arguments over phonics vs. "whole language" approaches to teaching reading, for example. Although Frank Smith, author of one of the definitive textbooks on the nature of the reading process, now in its fifth edition (1994), argues that letter and word identification are not necessary to reading, he does concede that when readers cannot get meaning directly, there is the possibility of mediated letter or word identification, sometimes using phonics or other strategies (Smith, 1994, p. 151-166). Thus, identification does play a role, albeit limited, in literacy.

Identification is taught and learned early. Consider Sesame Street, possibly one of the most successful programs on television for children ever created. When the show says "today's episode was brought to you by the letter L and the number 3," and when the live segments between characters are separated by "ads" for L and 3, the show is working to help kids identify the letters and numbers. This is one kind of screen interaction that supports the development of identification skills. Those letters on the chart over the blackboard in elementary school classrooms are another way of building identification skills. The point here is that the process, on paper or screen, with text or image, is the same.

The process by which recognition or identification occurs in literacy is just a specialized form of a more generalized ability to recognize shapes, again as applicable to web-based literacy just as it is to print. This more generalized ability is described by Pinker, building on the work of

Biederman (Pinker, 1997, p. 270). Biederman specifies a core set of twenty-four shapes he calls geons and a small set of methods by which they attach to one another. Like the grammar of language or any other emergent system, the small set of shapes and attachments accounts for human ability to recognize thousands of shapes. Moreover, Pinker notes that

> Language and complex shapes seem to be neighbors in the brain. The left hemisphere is not only the seat of language but also the seat of the ability to recognize and imagine shapes defined by arrangements of parts. (Pinker, 1997, p. 271)

The proximity of these functions in the brain suggests a relationship between them. It is a fundamental processing capacity that makes literacy possible, regardless of whether that literacy works on print or on a screen. Indeed, the ability to recognize or identify shapes works for letters and especially also for images such as those on a website.

Geons and their connections are one part of recognition and identification, but some other basic principles are needed, as Pinker points out. The main principle is mental rotation ability, along with awareness of left/right relationships and the idea of an axis on which a figure might turn (Pinker, 1997, p. 274-284). These are all part of the basic set of visual principles that make literacy do-able for humans. And there is one final principle of the visual system to be considered as a basic tool. Pinker describes the "Perky effect," named for Cheves Perky who discovered it in 1910 (Pinker, 1997, p. 288). The principle is that a mental image wipes out fine visual details, and often people merge images and what is actually seen. The implications of the Perky effect for reading are quite important: we mostly don't see what is on the printed page, but have images, certainly of letters and words, in our heads. This phenomenon further accounts for the high speed of proficient reading and may also account for our ability to process web pages as fast as we can load them to computer screens.

Identification/recognition is a key feature of our perceptual abilities, making book and screen literacy possible. We can identify or recognize letters, words, meanings, and images. If Smith is right, beyond beginning reading, we don't need the ability to identify extensively under ordinary conditions. On the production side, again beyond the learning stage, the actual identification of letters and words is completely automatic and not a process we attend to at all in the production of written language. Unless I am typing numbers or symbols, for example, I never think about the individual letters my fingers are touching on the keyboard. While my typing speed does not approach my reading speed, I am pretty fast and I suspect I am typical. A different example of this phenomenon comes from my daughter, a highly skilled user of Instant Messaging. She has pointed out that using such a system requires users to be high-speed typists. Handwriting is necessarily slower, but, once proficient, is the same process wherein we do not think about individual letters or words but are processing meaning directly. Still, identification is a fundamental tool, needed and available when some mediation is required.

Categorization

A second cognitive tool for dealing with representations of ideas in textual or image-based form is the ability to categorize a range of possible shapes as belonging to the same group. As I have noted in my earlier work (Horning, 2002), categorization is not the same as identification, which specifically refers to labeling ability. Having categorization ability as Pinker has described it (1997, p. 127), that is, an ability to sort items into groups and note common rules or patterns that all members follow, has implications for reading and writing discussed by Frank Smith. Smith points out that identifying letters or words is not that hard, as it entails only labeling. Putting items into a category is more complex since it entails knowing the

features of the category. In this way, categorization represents and higher level of ability, consistent with reading as an emergent system. He makes the distinction between these two abilities clear as follows:

> Two aspects of letter identification can be distinguished. The first aspect is the establishment of categories themselves and especially the allocation of category names to them, such as "A," "B," "C." The second aspect of letter identification is the allocation of visual configurations to various cognitive categories—the discrimination of various configurations as different, as not functionally equivalent. The great part of perceptual learning involves finding out what exactly are the distinctive features by which various configurations should be categorized as different from each other, and what are the sets of features that are criterial for particular categories. (Smith, 1994, p. 113)

Identification, he goes on to say, is not necessary in order to be able to categorize or discriminate among categories. By using the sets of features, both processes are possible.
Smith further suggests that the exact feature list is not essential to either identification or categorization, suggesting, I think, that the features may well be intuitions. Even if they are, we can also state them explicitly in many instances. In any case, the ability to name (i.e., identify or recognize) and the ability to group like items together (i.e. to categorize) are basic tools of human thinking ability that make critical literacy possible. We need this ability to be literate whether with text on paper or with text, image and sound on the screen.

The two processing abilities discussed so far make it possible for us to sort meaningful from meaningless differences when reading (Goodman, 1996). Thus, we know that 'A' and 'a' are both "a". We can put these symbols, though they do not look alike, in a single category and label it. A similar kind of activity makes it possible to read words and sentences by extension. While we do not need to do these things for every aspect of reading and writing, these are, again, the basic mechanisms by which literacy is accomplished. It is categorization that allows us to read bad handwriting, distorted print like a smeared newspaper or different type faces. Categorization is a fundamental tool for literacy. My own attempts to learn Hebrew, for instance, were easily thrown off by trying to move between the primer text I was using to learn the letters and the prayer book which had a smaller font size and slightly different shapes for the letters. It is part of the reason why story books for beginning readers are printed in large type fonts.

Both Pinker and Smith discuss the ability to categorize. Pinker shows how the process works, and why it is relevant to critical literacy, while Smith demonstrates how categorization makes literacy possible. Pinker explains where the ability to categorize fits in human cognitive ability:

> People think in two modes. They can form fuzzy stereotypes by uninsightfully soaking up correlations among properties, taking advantage of the fact that things in the world tend to fall into clusters (things that bark also bite and lift their legs at hydrants). But people can also create systems of rules—intuitive theories—that define categories in terms of the rules that apply to them, and that treat all the members of the category equally. …Law, arithmetic, folk science, and social conventions…are other rule systems in which people all over the planet reckon. The grammar of a language is yet another. (Pinker, 1997, p. 127)

So having categories is a general thinking strategy humans use, and they use it particularly with sets of rules, notably those of language.

Pinker makes a further point about the usefulness of categorization as a process. He notes that categories allow us to make inferences about how the world works. This ability to draw inferences is clearly pertinent to language. As Pinker says:

> Obviously, we can't know everything about every object. But we can observe some of its properties, assign it to a category, and from the category predict properties that we have *not* observed. (Pinker, 1997, p. 307)

This ability to predict based on categories is part of what is going on in the ability to process written language, both understanding and producing. We use the rules to do language, and the rules specify how categories of language behave or are used.

We categorize letters, words, sentences and other bits of language in terms of rules that they follow. Doing so is one aspect of critical literacy whether in print or on the screen. The ability to categorize applies usefully to looking at the visual array on a website just as it does to looking at a visual array of letters/words/sentences. It allows the sorting of information sites from shopping sites from news sites, among others, just as in print it allows readers to sort fiction from non-fiction, poetry from plays and so on. Kress (2003, p. 84-121) explores the importance of genre to the screen literacy, claiming that there is a great deal of genre mixing on the screen. From the analysis provided by Pinker, Smith and others, it seems clear that the fundamental ability to put arrays into categories is consistent across various forms. Categorization is one of the fundamental abilities human beings have that makes literacy possible, on the screen or the page.

Discrimination

A third processing ability is discrimination. Discrimination does not require either identification or categorization, but is a separate kind of ability. It is not necessary to be able to identify (i.e. label) two items in order to discriminate between them. It is also not necessary to categorize two items in order to discriminate between them. It is the ability to perceive two items as the same as or different from each other. This ability is important in a number of different kinds of cognitive processing, including literacy, both print and electronic.

The differences among discrimination, identification and categorization are made clear in the following example:

In many perceptual domains, discrimination is better than identification. We can usually discriminate between two different stimuli much better than we can label or identify two different stimuli. Consider the following example from the visual domain:

> Let us imagine a series of photographs of two men who look somewhat alike. We could photograph each standing up with arms pressed against his sides. We could then take a second, third and fourth photograph of each individual, asking each of them to raise his arms about 20 degrees for each photograph. The discrimination task would be to ask the viewer whether a pair of photographs were identical or not. The identification task would be to label the identity of the person in the picture. In this example you would not find it difficult to tell whether any two photographs of the *same* individual were identical or not (discrimination). (Yeni-Komshian, 1998, p. 133)

In this example, the categorization task might be to sort the photos of men with their arms down from those with their arms raised. These are distinct kinds of processing abilities, all of which provide the organizing principles that create a framework for print or web-based critical literacy.

Yeni-Komshian goes on in her discussion of speech perception to discuss the importance of the ability to discriminate different speech sounds in order to comprehend spoken language

(pp. 134-136). Moreover, the work of Eimas, Siqueland, Jusczyk and Vigorito (1971), investigating newborn children's ability to perceive the major phoneme categories in spoken language, demonstrates clearly that humans come equipped with this essential processing capacity. Yeni-Komshian also makes one further point: the ability to categorize is not limited to speech perception, but appears to be a more general processing or perceptual ability (p. 135).

The relationship of discrimination to identification or recognition and the differences between these processes is central to literacy. It can be clarified as follows: "Object recognition involves two aspects, discrimination and naming. The first is essential whereas the second is not… We perform many discriminations for which we have no verbal categories" (Wade & Swanston, 2001, p. 5). We also perform many discriminations for which we DO have verbal categories. Discrimination is an essential principle for literacy, whether in print or on the web and is essential to processing both text and images.

Reading as Emergence

As I noted at the outset, Gunther Kress claims that literacy in the "new media age" is fundamentally different from the other kinds of human literacy (2003, p. 1). But reading entails fundamental processes that must be in operation whether we are reading images on a screen or printed letters on paper, so the claim Kress makes is open to debate. Steven Johnson's approach to the "new media age" suggests that there are essential underlying patterns in how humans "read" the Internet that make it an emergent system like others he has studied, entailing use of neighbor interaction, pattern recognition, feedback, and indirect control. Johnson's analysis of people's interaction with the Web shows how it shares these key characteristics with human neighborhoods and ant colonies. Steven Pinker's approach to the "new media age" offers an explanation of the underlying cognitive processes of reading as an emergent phenomenon. His research, supported by the work of Frank Smith and other psycholinguists, makes clear that when we read, we rely on mental processes that use the visual system and draw on our abilities to identify, categorize and discriminate in order to be literate. These commonalities in the underlying behaviors and mental processes essential to literacy suggest that while the place we are looking at in the "new media age" may be different, i.e. screen rather than page or image rather than or in addition to text, the basic processing is the same.

Johnson's claims about the nature of emergence help to explain key features of how the Internet operates. As we spend more and more time looking at screens, reading text and processing images, sounds and movement, our print-based reading skills will continue to be expanded in the ways Kress suggests, but the underlying processes essential to the "new media age" are ones we already have. The emergent features of reading work together with principles of visual processing and cognitive processing, including identification, categorization and discrimination, to make paper and electronic critical literacy possible for readers of pages and screens, texts and images.

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Alice S. Horning teaches Rhetoric and Linguistics courses at Oakland University in Rochester, Michigan, where she is also the Director of the Rhetoric Program. Her research focuses on the nature of literacy from the perspective of both reader and writer. Her recent books include Revision Revisited, published in 2002 (Hampton Press).